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Abstract. The report describes the work of the Health Physics Department at Risø during 1988. The activities cover dosimetry, instrumentation, radioecology, risk by nuclear activities and nuclear emergency preparedness. Lists of staff and publications are included.

The emphasis in the report has been placed on basic research and contractual work. However, service functions do constitute a substantial work load for the department.

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Contents

1. Introduction

The Health Physics Department has the responsibility for some general functions at Risø: dosimetry, instrumentation, environmental monitoring, and health physics preparedness. The section for applied health physics, however, is part of the Safety Department.

The department is also responsible for more extensive education in health physics. Apart from courses for the staff at Risø, this includes shorter courses and lectures for nurses, fire brigade inspectors, naval officers and many others. Furthermore, many of the staff members give lectures or otherwise assist in educational programmes at universities and give informative talks to societies and clubs.

For society at large, the department assists in answering inquiries and making statements or reports for the government and central administration.

Finally, it should be mentioned that the department is represented in a number of international committees, the most important of which are listed in Appendix 2.

2. Dosimetry and Instrumentation

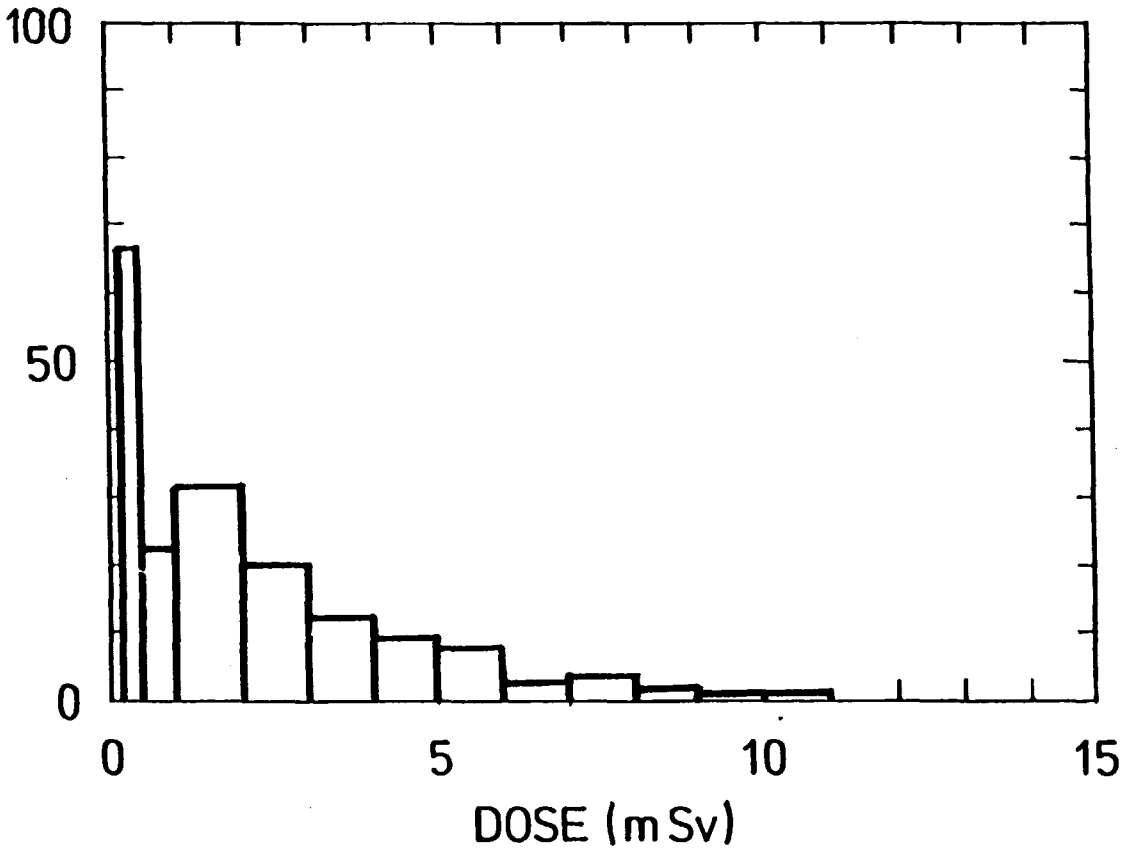
2.1. Personal Dosimetry

Risø's personal dosimetry service covers the individual monitoring of the personnel at Risø and the Niels Bohr Institute Tandem Accelerator. All workers and visitors staying at Risø for a period of more than two days are supplied with the Risø standard beta/gamma personal TLD badge. Additio- nal dosemeters, e.g. fast neutron films, quartz-fibre pen dosemeters, extremity dosemeters and criticality dosemeters are supplied according to special requirements. Urine samples are routinely collected in accordance with an established programme.

In 1988 approximately 2150 persons were monitored; of these, 182 persons received doses above the registration level for external doses of 0.2 mSv (20 mrem). The total dose (collective dose equivalent) registered to the monitored personnel was 0.34 man sievert (34 man rem). 74 persons received internal doses caused by intake of tritiated water. The contribution to the total dose from internal doses was 0.033 man sievert (3.3 man rem). The figure shows the distribution of the levels of the registered doses for 1988.

The dosimetry group has assisted CEC in preparing a document on technical recommendations for monitoring the exposure of individuals to external radiation. The work has been carried out on a contractual basis in co-operation with NRPB, UK and TNO, The Netherlands.

The group has furthermore participated in a co-ordinated programme of research in "Intercomparison Programme for Individual Monitoring". The programme was co-ordinated by IAEA and the work was carried out under a research agreement.



Distribution of yearly wholebody doses (effective dose equivalent) from 1988 for the Risø personnel.

2.2. Beta Dosimetry

The investigations of TL-dosemeters for application to personal beta dosimetry continued.

A co-ordinated programme among four laboratories (NRPB, PTB, Fontenay-aux-Roses, and Risø) made progress. The programme deals with the measurement of dose rates from ^{147}Pm sources at different distances and angles from the sources. Sources have been exchanged between the labora- tories to verify the measurements. The programme is planned to proceed in using other beta sources.

2.3. Neutron Dosimetry

CR-39 track detectors have been further investigated with the aim of routine application in personnel neutron dosimetry. A number of detectors was irradiated at GSF Neuherberg and PTB Braunschweig under a programme of joint neutron irradiations organized by Eurados-Cendos. Further irradiations will be provided by PSI Würenlingen in the beginning of 1989.

2.4. Phantom for Internal Dosimetry

An experimental programme for determining the radiation doses absorbed in target organs from radionuclides deposited in different source organs is in progress on a constructed phantom.

The importance of tissue-substitute compositions in the phantom has been investigated. It is concluded that water is a good substitute for different tissue-equivalent liquids for measurement of internal β- and γ-doses, and that mass density is the most important parameter for the absorbed β-dose. Measurements were made on different lung tissue substitutes representing the lungs in their median respiratory state with a low density. The results indicate that factors other than the mass density may influence the absorbed β-dose. Further measurements are planned on granule materials with a more realistic elemental composition.

2.5. Radon Investigations

An investigation of factors influencing indoor radon concentrations was carried out in 1986-1987, and the results were reported in 1988. Additional integrating radon measurements have been carried out in 12 houses on a 2-month basis throughout 1988. This measurement programme continues in 1989.

Integrating measurements of outdoor radon concentrations have been made at a number of sites in the Sarfartoq area in Greenland in three periods in 1987-1988. The measurements were done for the Greenland Environmental Research Institute as a part of environmental base line studies in relation to plans for the exploration and exploitation of a niobium occurrence. At most of the sites the radon concentrations are generally low, i.e. 2-5 Bq/m^3 on average. However, the occurrence of rocks with an elevated uranium content within the area is partly reflected in higher radon concentrations at some sites. The measurement programme continues.

2.6. Environmental Dosimetry

As part of the environmental monitoring programme carried out by Risø, gamma background exposure levels at different sites in Denmark are routinely measured by means of LiF TLD-700 dosemeters. The integration times used are 6 months for zones surrounding the Risø facilities and 12 months for selected sites elsewhere in the country. The mean exposure levels, expressed in units of absorbed dose in air per hour, for different parts of Denmark in 1988 are given in the following table:

Location	Mean exposure rate (nGy/h)*
Risø area	72
Zealand and islands	79
Jutland	69
Bornholm (Baltic island)	93

* cosmic component is included

2.7. Instrument Service

The instrument service covers routine calibration and maintenance of approximately 650 health physics survey instruments of which approximately 50 are positioned outside Risø as part of emergency arrangements. In ad- dition, the instrumentation group is responsible for the operational perform- ance and calibration of area- and effluent monitoring systems installed at nuclear facilities at Risø.

2.8. Low-level Anticoincidence Multicounters

The development of gas-flow anticoincidence multicounters for alpha and beta counting applications was continued. The previously used electronics that incorporated counting channels, anticoincidence gates, scalers and display were replaced by a newly developed circuit plug-in board intended for installation directly into an IBM-compatible personal computer slot. The multicounter system is thus entirely controlled by the PC. Further programs for calculating statistics were developed. Live display is provided on the computer screen of all counting channels including the guard counter.

Two computer-controlled 5-sample proportional multicounters for simultaneous counting of alpha and beta activity from 60-mm diam. filter paper samples were developed and installed at the research reactor DR3 for routine measurements.

Six new 5-sample beta GM multicounters were stacked into one unit and installed at the radioecological laboratory of the Health Physics Department for $^{90}Sr/^{90}Y$ and ^{99}Tc environmental measurements.

Four 5-sample GM multicounter systems for measuring radioecological beta samples were produced and delivered to Institute Petten, Holland; Chalmers Technical University, Sweden; Finnish Centre for Radiation and Nuclear Safety, Finland and Gesellschaft für Strahlen- und Umweltforschung, W. Germany.

2.9. Thermoluminescence Instrumentation

A new flexible software was developed for the automated Alnor TL-reader especially designed for the determination of environmental gamma radiation. The new program stores all glow curves so that they can be recalled for analysis e.g. in connection with control of the recorded doses.

New software was also developed for the automated Risø TL system for research and analysis. A complete Risø TL system with new software and computer was produced and delivered to Gesellschaft für Strahlen- und Umweltforschung, W. Germany.

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3. Radioecology

3.1. Environmental Radioactivity

The studies of environmental radioactivity were continued in 1988. Radiostrontium was determined in samples taken from different parts of the country of precipitation, ground water, drinking water, sea water, dried milk, grain, bread, potatoes, vegetables, fruit, total diet, and human bone. Furthermore, ^{90}Sr was determined in local samples of air, rain water, marine sediments, grass, sea plants, fish, and meat. Radiocesium was determined in air, precipitation, sea water, sediments, milk, grain products, potatoes, vegetables, fruit, total diet, sea plants, fish, and meat. Estimates of the mean content of radiostrontium and radiocesium in the human diet in Denmark were reported. Tritium was determined in precipitation, fresh water and sea water. Plutonium and americium were measured in various environmental samples.

The Chernobyl accident in April 1986 resulted in a substantial supplementary monitoring programme for Denmark, the Faroe Islands, and Greenland, and this programme was continued in 1988 with some adjustments. The radionuclides of utmost importance in 1988 were still ^{137}Cs, and ^{134}Cs. A number of countries requested that imported food products from Europe be accompanied by a certificate stating the radioactivity content of the product. About 1800 such certificates were issued in 1988.

The γ-background was measured regularly with TLDs and scintillation detectors at locations around Risø, at ten of the state experimental farms, along the coasts of the Great Belt, and around Gylling Næs.

The marine environment at Barsebäck was monitored for ^{137}Cs and corrosion products (^{58}Co, ^{60}Co, ^{65}Zn, ^{54}Mn).

Samples of various foods and drinking water from Greenland and the Faroes were analysed for ^{90}Sr and ^{137}Cs. Chernobyl debris was also detectable in these samples.

3.2. Nordic Chernobyl Data Base

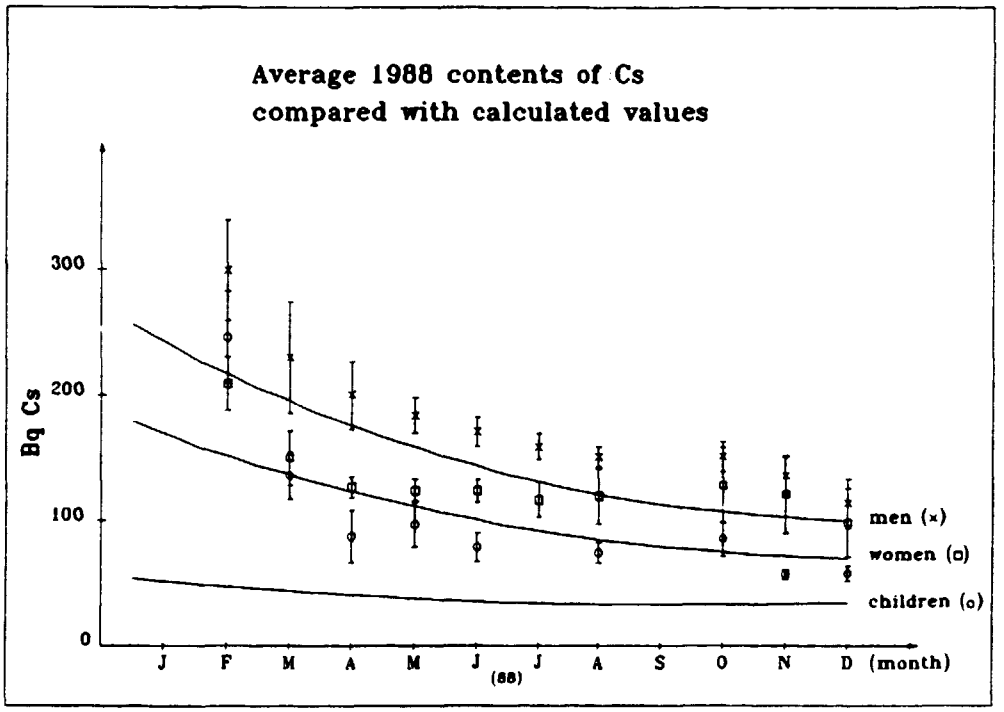
Chernobyl fallout data are collected from all the Nordic countries into a common data bank. The bank, which is partly financed by the Nordic Council of Ministers, is intended to be connected to the CEC REM-bank in Ispra.

The bank will utilize the new data handling system (CBASE) which is under development at Risø. The development work has progressed such that usable versions are running on PCs and VAX.

In connection with the Nordic Chernobyl Data Base an inter-Nordic intercalibration has been accomplished.

3.3. Wholebody Counting of Radiocesium

The content of ^{134}Cs + ^{137}Cs has been measured monthly in a selected group of Danes consisting of 8 women, 7 men and 4 children. The mean content of radiocesium is shown in the figure below (marks). The variation in the measured concentrations agrees well with theoretical predictions (solid line on the figure) for Zealanders.



By measurements of the radiocesium content following an ingestion of 40 kBq of ^{137}Cs, the biological half-life of cesium in a male and a female has been obtained. In both persons, approximately 25% of the ingested radiocesium is excreted within a few days and the rest with a half-life of about 80 days.

3.4. Dynamic Models of the Human Food Chain

A computer program, TAMDYN, has been developed for simulating the environmental transport of contaminants. This program was used to simulate also the ^{137}Cs contamination in Denmark from Chernobyl.

In order to reproduce conditions in Denmark after Chernobyl, the input to the air compartment of the models was adjusted to produce air concentrations similar to those observed. The model predictions underestimate the measured values by a factor of about 2; this low estimate is due mainly to the low deposition values calculated by the model. The main part of the deposition at Risø arrived during rainfall, but the measured ground-level air concentrations were too low to account for the deposition, and thereby indicate higher concentrations at higher altitudes.

In order to demonstrate the sensitivity and uncertainty potentials of the model, calculations were made of ^{137}Cs in beef at the predicted maximum levels which occurred in the end of May 1986. The sensitivity analysis points out that the potential variation of the maximum beef concentration is caused by two parameters only. The plant interception factor accounts for 45% of the variation, and the conversion factor from muscle to beef accounts for 54%. From the uncertainties assigned to the parameters and keeping the above

concentration factor constant, an uncertainty analysis gives a distribution of maximum beef concentrations. Of this variation 80% originates from the plant interception factor and 10% from the washout coefficient.

This work was supported by CEC and the Nordic Council of Ministers.

3.5. Reduction of the Contamination Levels of the Rural Environment

The radioecology section is participating in a project on improving practical countermeasures against contamination in the agricultural environment. This project is part of the CEC post-Chernobyl programme initiated in 1987. In 1988 root uptake experiments with grass, barley and peas were carried out for various soil types using ^{134}Cs and ^{137}Cs. The aim of this project was to identify crops with relatively high or low root uptakes of cesium. Although such differences may be small, a shift in sorts might be a cost-effective prophylactic way to reduce collective doses. It appeared that one sort of barley and one of rye-grass had relatively higher root uptake of cesium than other sorts. On comparing the three species, the root uptake for barley is shown to be significantly lower than those of rye-grass and peas. In order to compare these three species, the common unit: activity per fodder unit was used. Although the root uptake from the organic soil was much higher than root uptake from the sandy loamy soil, the species and sorts showed the same pattern of growth in the two types of soil. During the project, certain signs of contamination due to resuspension and rainsplash occurred. The project will continue in 1989.

3.6. Uptake and Loss of Certain Transuranium, Fission, and Activation Nuclides by Mytilus and Fucus

The long-term in situ Mediterranean Mytilus loss experiment in Monaco (in collaboration with the IAEA laboratory) has been running satisfactorily during all of 1988. Compared with the earlier Baltic experiments, the growth rate is much higher. Preliminary results indicate that in spite of faster growth, higher temperature and higher salinity, the loss rates do not differ from the Baltic data as much as would be expected. As a new result, ^{106}Ru shows high retention and long biological half life in Mediterranean Mytilus.

A parallel laboratory experiment in Monaco has shown good agreement with the in situ Mediterranean experiment. In contrary to what was expected, no differences in biological half lives could be detected between two feeding regimes.

The 1985/86 Baltic long-term loss experiment in Oskarshamn gave significantly longer biological half lives but also much lower retention for the slow compartments than the earlier Baltic experiment from Forsmark. The reasons for this might be that the two experiments were started at two different seasons. In bioindicator context, the two effects counteract. However, it indicates one reason for the variability that must be considered in bioindicator monitoring.

Generally, results from the long-term loss experiments with Mytilus and Fucus indicate that for most elements studied, the growth rate is apparently more important for the concentration factor and for the bioindicator time

integration, than is the actual loss of elements from the slow compartments. This effect is caused by dilution of pollutants present in the bioindicators by new growth.

3.7. Determination of Less Well-known Long-lived Radionuclides

A new method for collecting ^{99}Tc from 200-400 litre sea water by anion-exchange was developed. An average overall radiochemical yield of 70% was found for Tc. Decontamination factors ere between 3×10^5 and 2×10^7 for Ru and 2×10^5 for Ag. A new method to determine ^{99}Tc in seaweed by wet-ashing and simple extraction into 5% TIOA/xylene was also developed.

The radiochemical procedures for Pu and Am in environmental samples have been scrutinized in order to obtain a more efficient decontamination for natural radioactivity, in particular Th.

A method was developed for the determination of ^{63}Ni in environmental samples. For a 3000 min measurement in a windowless anti-coincidence shielded gas-flow GM counter, the least-detectable activity was 1 mBq. The method was applied to a series of macro algaes (Fucus vesiculosus) collected at different distances from a nuclear power plant. The ^{63}Ni concentration in the algaes showed a good correlation with distance to the power plant. The relations between ^{63}Ni to ^{60}Co and ^{63}Ni to stable nickel were also investigated.

3.8 Studies of Radioelements in Seawater Sediments, Seaplants and Mussels in the North Atlantic Region

During September Risø participated in a cruise with the Icelandic research vessel Bjarni Sæmundsson under the International Greenland Sea Project. At 5 stations between Jan Mayen and East Greenland and at 2 stations further south in the Denmark Strait between Iceland and Greenland, depth profiles were sampled with 270 l water samplers. ^{99}Tc, radiocesium and ^{90}Sr will be measured. In the same 7 profiles and at the same depths, the physical oceanographers moored automatic recording current meters, which are expected to measure continuously for the next 5 years. Furthermore, CTD profiles were taken. The close correlation with the physical oceanographic programme is expected to improve the use of the radioactive tracers considerably.

Almost all samples from the June 1987 Polarstern cruise have been analyzed. It is now clear that the ^{99}Tc concentration in the North Atlantic region is not at all influenced by the Chernobyl accident. The greater part of the technetium signal in East Greenland waters originates from European fuel reprocessing. In 1987, surface seawater concentrations were measured as 50 - 100 mBq $^{99}Tc\ m^{-3}$.

In co-operation with the German Hydrographic Institute, Hamburg, 26 samples of surface seawater were collected in the North and Irish Seas and in the English Channel. The samples were analysed for ^{99}Tc. The highest concentrations were found close to Sellafield and east of Cap de la Hague. The lowest were seen around Cornwall and in the northern part of the North Sea.

The major effect of Chernobyl in the North Atlantic region is the increased radiocesium level. For the Baltic Sea as a whole, the accident increased the amount of ^{137}Cs by a factor 20. The total inventory of ^{137}Cs in the Baltic was

estimated at 5 PBq. In 1987 the ^{137}Cs level in the northern part of the Norwegian Sea and in the West Spitzbergen Current was doubled and in the Greenland Sea area it varied from a doubling to an increase of a few percent.

3.9. Environmental Studies of Plutonium and Americium at Thule, Greenland

A number of lichen samples collected in 1984 on Saunders Island, Thule, 10 km WNW from the point of impact showed enhanced Pu and Am levels. The radionuclide ratios showed that the activity was from the accident in 1968. Compared with the Pu levels in lichen in 1968, the effective half life of Pu in the Thule lichens was estimated at 5-10 years. ^{241}Am apparently had a longer half life than Pu.

3.10. Long-term Tagging of Elvers, Anguilla Anguilla, with Radioactive Europium

What happens to larval or small post-larval fish that are set out in the environment to secure a natural population? Do they ever reach maturity in amounts sufficiently large to influence fishery in practice? In order to answer these questions, one needs a fish mark that can be introduced through food or water and which will follow the animal throughout a major part of its further growth.

1300 ^{155}Eu-labelled elvers (50 Bq/eel), each weighing on the average 0.21 g, were set out near Oskarshamn on the east coast of Sweden in June 1982. Two of these were caught nearby in April 1988 and July 1988, when they were 41 and 48 cm long; they weighed 116 and 188 g, respectively.

About 10,000 ^{152}Eu-labelled elvers were set out under similar conditions in June 1984. Five of them were caught in March and April 1988. They averaged 36 cm in length and 69 g.

A total of 486 eels were caught and tested in 1988.

3.11. Membrane Lipids in the Eel, Anguilla Anguilla, Affected by Environmental Factors

This project aims to study the mechanism of salt transport in marine animals and how this mechanism is affected by various environmental factors.

More evidence points directly to the mitochondria as the cell fraction involved in the membrane lipid changes, seen previously in connection with osmoregulation in the eel (Anguilla Anguilla).

The project covers also the adaption of lipid metabolism to long-term starvation in the eel (Anguilla Anguilla).

Recent results can be summarized as follows:

1. In the fed state, the same relative incorporation of injected ^{14}C-labelled alanine, serine, aspartate and glutamate into glyceride-glycerol in eel liver in vivo points to the enzyme phosphoenol-pyruvate carboxykinase as rate limiting in gluconeogenesis.

2. Equivalent experiments in the fasted state show an enhancement of the incorporation of ^{14}C-activity into glyceride-glycerol, twice as high from either alanine, lactate or pyruvate, and seven times as high from serine as that from either aspartate, glutamate, acetate or propionate.

3. This difference between the incorporation of specific precursors depending on nutritional state is interpreted as a hormone-induced compartmentation of gluconeogenesis in favour of an effective protein utilization in the fasted eel.

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4. Elements of Risk by Nuclear Activities

For many years, the Health Physics Department has been engaged in calculations of the consequences of large nuclear accidents. In recent years, the effort has focused on radioactive contamination with emphasis on urban environments. The work is partly financed by CEC (the MARIA research programme) and by the Nordic Council of Ministers (the NKS/AKTU programme).

4.1. Puff Model

An operational hazard assessment technique was developed to investigate impacts of high concentrations from pollutants emitted in complex terrain. In such environments, atmospheric dispersion is influenced not only by turbulent mixing and diffusion of the cloud itself, but also by topographically induced wind shear, channelling, local slope flows and hill-curvature speed-up effects, etc.

A puff-splitting technique is introduced into the puff dispersion model (RIMPUFF) which in connection with a fast, diagnostic mean-flow model (LINCOM) simulates both bifurcated and shear-induced spread over complex terrain. The combined models have been applied in a climatological study of

possible release hazards at the Vandenberg Air Force Base, California. Ten major flow types, spanning a range from stagnation to sea breeze, drainage to synoptically dominated conditions, have been classified and characterized via tower and radiosonde data, and then simulated with the combined flow/puff model.

Based on the data from the Mountain Iron experiments, an intercomparison and verification study for the LINCOM and SRI COMPLEX flow models was started. The study will include a comparison of the measured tracer concentration and the corresponding calculations with the Risø puff model.

Work with the on-line version of RIMPUFF is continuing using a restructured version of the code developed by GRS, Köln. The model could be used for monitoring the dispersion of material released in an accident in real time. A prototype of the model has been implemented on a Hewlett-Packard ES/12 personal computer.

A users guide for version 20 of RIMPUFF was written.

4.2. Dry Deposition

Dry deposition on rough surfaces such as trees and lawns was studied. It is found that the deposited material is distributed fairly uniformly on trees and that the deposition velocity is nearly proportional to the mass of the bulk material (small branches, twigs and needles) per unit projected area. Therefore, it is suggested that a bulk deposition constant be used when modelling deposition on trees. The bulk deposition constant, B_d is defined as the amount of deposited material per unit bulk mass divided by the time-integrated air concentration. B_d values for different trees are shown in the following Table.

Bulk deposition constant, B_d: 10^{-4} m^3 s^{-1} kg^{-4} for several varieties of tree.

Isotope	Yew height 2.5 m	Jupiter berry height 2.0 m	Common spruce height 6.5 m	Common spruce height 6.1 m
^{137}Cs	2.8	3.2	1.8	2.3
^{134}C	2.2	2.7	1.4	1.9
^{131}I	24.5	26.5	19.4	16.6
^{141}Ce	12.2	21.9	13.9	19.4

The deposition velocity changes much more rapidly than does B_d, from sample to sample. The bulk deposition constant, therefore, often proves to be a more useful parameter than the deposition velocity when modelling deposition on grass surfaces.

4.3. Internal Deposition

Beryllium-7 particles are used as tracers for investigating the deposition of small particles on surfaces in furnished and unfurnished houses.

The deposition velocity in the unfurnished room is about 3 times less than in the furnished room. The deposition velocity for the partly furnished house is in-between. Higher deposition velocities for ^{137}Cs-marked particles compared with ^{7}Be-marked particles are due to the larger particle size of the former as they stem from resuspended material.

4.4. Run-off and Weathering

The weathering and run-off from roofs was studied. It was found that the weathering process is very slow when considering cesium retained during the Chernobyl accident.

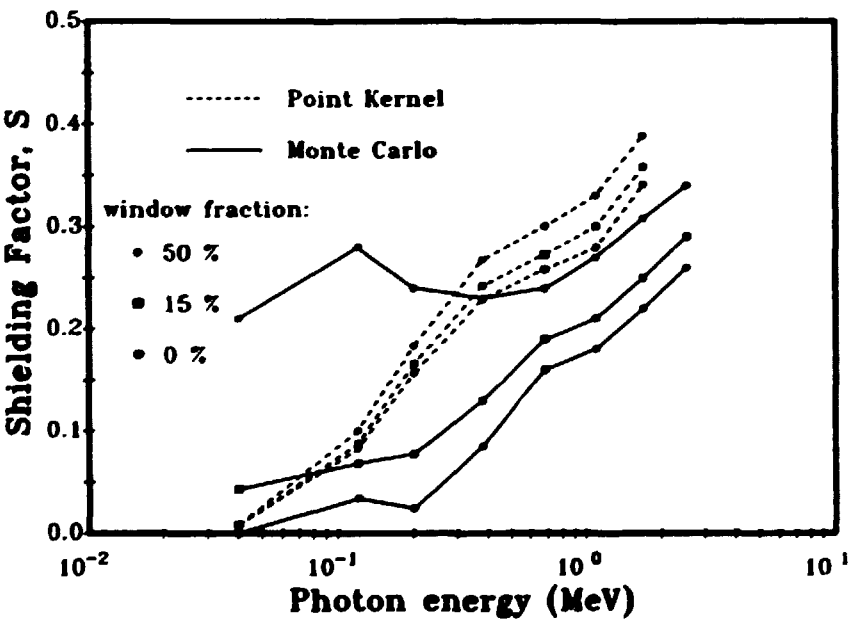
4.5. Shielding Factors for Plume Radiation

The mathematical model for calculating the indoor radiation dose from a Gaussian plume has been further developed and improved regarding the influence of window apertures. Building types are described as a composite of cubic boxes, and attenuation and scattering in the walls and floors is accounted for in the numerical integration of the point kernel over the plume volume.

For a traditional Danish single-family house, the plume/building geometry was varied. Two different atmospheric stability categories (Pasquill D and F), two different heights (0 m and 100 m), four different downwind distances and two different crosswind distances were used.

To account for the poor shielding of windows, the outer wall thickness in the model is decreased to an effective thickness that will depend on the fraction of outer wall area covered by windows. This "window-smearing" method gives shielding factors at low photon energies that are too low. Therefore, the model has been further developed so the real window apertures can be described.

As the point kernel method has some limitations, Monte Carlo calculations have been made for the simple blockhouse. The results are shown in the figure below, where also the corresponding point kernel results are shown for comparison.



Shielding Factors for a Simple Blockhouse Calculated from Point Kernel and Monte Carlo Methods.

A temporary conclusion is that the point kernel method underestimates the indoor protection against plume radiation compared to the corresponding Monte Carlo results.

4.6. Decontamination of Streets and Houses

In order to identify some parameters necessary for calculations of dose rate to the population of a radioactively contaminated urban area, some in situ measurements of radioactivity on external urban surfaces were carried out in August 1988 in the town of Gävle in Sweden. The town was contaminated mainly by wet deposition from the first cloud from the Chernobyl accident on 27 April 1986.

The measurements showed the distribution of the contaminant radiocesium to be dependent on both the nature and orientation of the surfaces. The levels found on walls were only 1-2% of those on grassed areas, whereas on roads, pavements and car parks the figure was nearly 30%.

Decontamination tests were carried out on brick walls, but the levels of radiocesium before and after treatment did not differ significantly.

4.7. Work for the Swedish State Power Board

As a last contribution to the Swedish State Power Board's safety documentation to the authorities, two calculations were made for consequences after postulated severe accidents.

For Ringhals reactors 3/4, the consequences were calculated based on a hypothetical core melt down, caused by total power failure. It was assumed that an installed scrubber would decontaminate the release with a factor of 500. Deposition of methyl iodide was taken into account.

For Forsmark reactor 3, the consequences following a similar scenario, were calculated with the assumption of a burst plate break at the same time as tank melt-through.

An investigation was completed of the radiation levels to be expected within the site of Ringhals in case of a hypothetical severe accident. The PLUCON4 code and RIMPUFF model were both used in the investigation.

4.8. Design Safety Guidelines for Next European Torus

Risø participates in a working group within the European fusion technology programme. The task is to write a set of design safety guidelines for the next European torus and next generation of fusion devices.

Risø contributed to the guidelines on radiological safety, (DSGWG 88-01), external hazards (DSGWG 88-03) and non-ionizing radiation (in preparation).

List of Publications

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Thykier-Nielsen, S.; Gryning, S.-E.; Mortensen, N.G., Puff Diffusion Model Simulations of Two Tracer Releases from the Øresund-Experiment. I: Real-Time Computing of the Environmental Consequences of an Accidental Release to Atmosphere from a Nuclear Installation. Luxembourg, 17-20 Sep. 1985. Proceedings. v. 2. (Commission of the European Communities) (DOC. No. V 2943/86) p. 479-499.

Warming, L., NET Design Safety Guidelines. EEC Fusion Technology Progress Report 1987 p. 88.

5. Nuclear Emergency Preparedness

5.1. Nationwide Nuclear Emergency Plan

The existing emergency preparedness plan for accidents at the Swedish Barsebäck plant, covering the northeastern part of Zealand, will be extended to cover the whole of Denmark taking other nuclear power plants into consideration. The Danish Civil Defence and Emergency Planning Agency is responsible for the plan and the Health Physics Department renders them consultative assistance.

Ten permanent automatic on-line monitoring stations are planned to register continuously the ambient background gamma radiation level. Measurements will be stored in a microprocessor unit, which also controls the functioning of the stations. Via a telecommunications network, data from the stations will be transmitted to an on-line central computer system at Risø and an identical system in the National Emergency Control Center in Copenhagen.

A test station is in function and is collecting information at the laboratory. Preparatory work has been done on software development. Further work is awaiting a final decision on the system lay out. The ARGOS (Accident Reporting and Guiding Operational System) computer system will be modified and installed in the central computer. ARGOS facilitates transmission, registration, evaluation and presentation of monitoring data from a large number of locations. The data are presented on colour screens, prints or plots on suitable maps with the possibility of showing isocurves, population data and estimated doses.

The department rendered assistance to the Danish Civil Defence and Emergency Planning Agency in connection with COSMOS 1900 event in the autumn.

5.2. Alarm Criteria for Permanent Monitoring Stations

Under a CEC-contract, software is developed in order to facilitate the evaluation of data from stations, monitoring the ambient background radiation. Two instruments, a 3-in NaI crystal, giving a 256 channel spectrum, and a sensitive ionisation chamber, giving the actual dose rate, are monitored on-line. Software programs for distinguishing the meteorological conditions (especially rain) are being developed in order to increase the sensitivity. The history of the station's background level is stored and treated in order to facilitate the recognition of radioactivity released from nuclear accidents.

5.3. Work for the Swedish National Institute of Radiation Protection

As a part of the co-operation with the Swedish National Institute of Radiation Protection, the department has participated in the planning and execution of an emergency drill for the Oscarshamnsverk.

List of Publications

Gjellerup, U.; Walmod-Larsen, O., Det betyder det. Civilforsvar (1988) (no. 1) p. 11-13 (in Danish).

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Appendix 1

STAFF OF THE DEPARTMENT

Scientific Staff

(number refers to the relevant sections of this report)
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Appendix 2

PARTICIPATION IN INTERNATIONAL WORKING GROUPS, ETC.

IAEA, The International Atomic Energy Agency

Co-ordinated research program "Sources of radioactivity in the marine environment and their relative contributions to overall dose assessment from marine radioactivity". (Chairman: Aarkrog).

Advisory Group on Principles for Establishing Intervention Levels for the Protection of the Public in the Event of a Nuclear Accident or Radiological Emergency. (Hedemann Jensen).

Group of Coordinated Research on Validation of Models for the Transfer of Radionuclides in Terrestrial, Urban, and Aquatic Environment (Chairman for urban environment: Roed).

Advisory Group on Methodology and Technology for Clean-up of Very Large Areas After a Nuclear Accident (Roed).

OECD, Nuclear Energy Agency

Committee on Radiation Protection and Public Health (Gjørup).

CSNI-PWG4, Subgroup of Experts on Accident Consequences (Thykier-Nielsen, Roed).

CSNI, Working Group on Fuel Cycle Safety (Roed).

CRESP, Executive Group for Research on Sea Disposal of Radioactive Waste (Aarkrog).

CRESP, Radiological Surveillance Task Group (Dahlgaard).

CRESP, Modelling Task Group (S.P. Nielsen).

Commission of the European Communities

Article 31 Committee, Basic Safety Norms (Gjørup).

Article 31 Committee, Working Group concerning Sellafield (Gjørup).

Article 35 and 36 Group of Experts (Dahlgaard).

Article 37 Group of Experts (Walmod-Larsen).

CGC on Radiation Protection (Gjørup).

Working Party on the radiological impact on the populations of member states of radioactive waste disposed of in the Northeast Atlantic (project MARINA) (chairman: Aarkrog).

MARINA, Modelling Group (S.P. Nielsen).

Expert Group on Safety and Environment for the European Fusion Programme (Warming).

Expert Group on Environmental Gamma Monitors (Bøtter-Jensen).

Expert Group on Transfrontier Emergency Planning (Walmod-Larsen).

Group of Technical Experts on Radiation Protection Dosimetry (Christensen and Majborn).

EURADOS-CENDOS, Beta- and Low-Energy Photon Dosimetry (Christensen).

EURADOS-CENDOS, Personal TLD Dosimetry (Christensen).

Helsinki Commission

Group of Experts on Monitoring of Radioactive Substances in the Baltic Sea (Aarkrog, Dahlgaard).

European Atomic Energy Society

Public Relations Correspondents Group (Walmod-Larsen).

International Committee for Radionuclide Metrology (S.P. Nielsen).

International Union of Radioecologists (IUR)

President: Aarkrog
IUR, Marine Radioecology Working Group (leader: Dahlgaard).

Nordic Cooperation

Steering Committee for the AKT projects (Heikel Vinther).

BIOMOVS

Biospheric Model Validation Study (S.P. Nielsen).

Editorial Boards

Journal of Environmental Radioactivity (Aarkrog).

Radiation Protection Dosimetry (Bøtter-Jensen).

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The report describes the work of the Health Physics Department at Risø during 1988. The activities cover dosimetry, instrumentation, radioecology, risk by nuclear activities and nuclear emergency preparedness. Lists of staff and publications are included.

The emphasis in the report has been placed on basic research and contractual work. However, service functions do constitute a substantial work load for the department.

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